Kuwait University **Physics Department**

Physics 101

Solution of Second Midterm Examination

December 2, 2001

Sunday, 12:30 – 2.00 PM

Student's Name: ---------------------------------------
Student's Number: ---------------------------------------
Instructor's Name: ---------------------------------------

Instructors

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Four use by Instructor only

Problem	1	2	3	4	5	6	7	8	9	Total
Marks										

1- Answer all questions
2- The solution should be given explicitly for each question
3- No solution = no grades
4- Check the correct answer for each question
5- Take g=10 m/s^2

[1] A force of magnitude F=100 N pulls a 20 kg block along a frictionless plane that makes an angle $\theta = 37°$ with the horizontal. The acceleration of the block shown in Fig. 1 is

(a) 2 m/s^2 (b) $-2 m/s^2$ (d) 10 m/s^2 (d) -10 m/s^2 (e) other

Solution

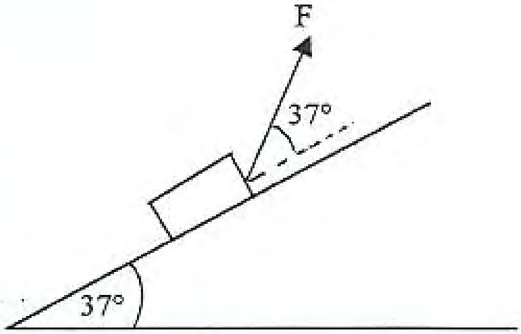

Fig. 1 Problem 1

$$a = \frac{F\cos\theta - mg\sin\theta}{m} = \frac{(100)(0.8)-(20)(10)(0.6)}{20} = -2m/s^2$$

downward acceleration

[2] Two objects of masses 2M and 3M slide on a frictionless surface under the effect of two forces F and 2F as shown in Fig. 2. If F = 60 N and M=1kg, the magnitude of the force exerted on the large block by the small block is

(a) 12.0 N (b) 120.0 N (c) 228.0 N (d) 84 N (e) other

Solution

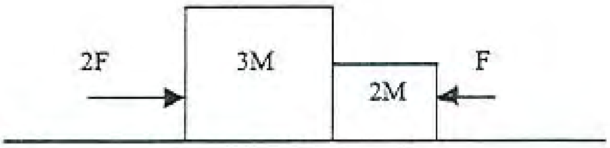

Fig. 2 Problem 2

2F-P = 3 M a (1)

2F – F = 5 M a (2)

From equation 2: F = 5 Ma → a = F/ (5 M) = 6/5 = 12 m/s^2 (3)

Substituting for a into equation (1) P = 2 F – 3 M a =2 (60) – 3 (1) (12) = 120 –36 = 84 N

[3] The true weight of a man is 1000 N. If his weight while standing in a moving elevator is 800 N, then the elevator's acceleration is

(a) 0 m/s^2 (b) –2 m/s^2 (c) 2 m/s^2 (d) 9.2 m/s^2 (e) other

Solution

Mg =1000
M=1000/10=100 kg
M(g+a)=800 N
Mg + Ma = 800
1000 + 100 a = 800
a = -200/100 = -2.0 m/s^2
means upward motion with decreasing speed as in (c).

[4] The coefficient of kinetic friction between the block and the incline is 0.29. When the system in Fig. 3 is released from rest, the acceleration of the suspended block as it falls is

(a) 1.2 m/s^2 (b) 6.25 m/s^2 (c) 3.8 m/s^2 (d) 5.6 m/s^2 (e) 7.9 m/s^2

Solution

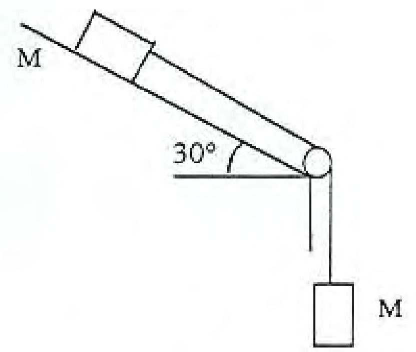

Fig. 3 Problem 4

$$a = \frac{\sum F}{M+M} = \frac{Mg + Mg\sin\theta - \mu_k(M)g\cos\theta}{2M} = 6.25 m/s^2$$

[5] A banked (tilted) highway curve is designed with an angle of 20.1° which makes reliance on friction unnecessary. Suppose that a car moves around the curve with constant speed v and that the radius of the curve is R=50.0 m (Fig. 4). The speed of the car for rounding the curve without skidding is

(a) 13.4 m/s (b) 13.53 m/s (c) 36.96 m/s (d) 22.36 m/s (e) other

Solution

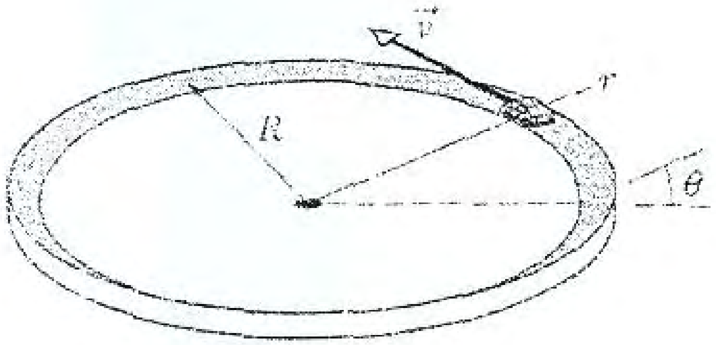

Fig. 4 Problem 5

$$N\sin\theta = \frac{mv^2}{R}$$

$$N\cos\theta = mg$$

$$\tan\theta = \frac{v^2}{RG}$$

$$v = \sqrt{RG\tan\theta} = \sqrt{(50)(10)\tan(20.1)} \approx \pm 13.4 m/s$$

$$s = 13.4 m/s$$

[6] A single conservative force $F_x = (4x^3)N$, acts on a 4-kg object, where x is in m. As the object moves along the x axis from x = 0 m to x = 4 .0 m, if its speed at x = 0.0 m is 4 m/s, then the speed of the object at x = 4.0 is

(a) 12 m/s (b) 11.6 m/s (c) -12 m/s (d) −11.6 m/s (e) other

Solution

$$W = Area = K_f - K_i$$

$$W = \int_{x_i=0}^{x_f=4} 4x^3 dx = 4\times[\frac{x^4}{4}]_0^4 = [256-0] \approx 256J$$

$$256 = \frac{1}{2}(4)(v_f^2 - 4^2)$$

$$256 = 2v_f^2 - 32$$

$$v_f = \sqrt{144} = 12 m/s$$

[7] A force acts on a 3-kg object in such a way that the position of the object varies with time as given by $x = 4 + 2t - 2t^2$, where x is in meters and t in seconds. The power delivered to the object at $t = 3$ seconds is

(a) 54 W (b) 46 W (c) 120 W (d) 96 W (e) 40 W

Solution

$$P = \vec{F}.\vec{v} = Fv$$

$$F = ma = m\frac{d^2x}{dt^2} = (3)(-4) = -12N$$

$$v = \frac{dx}{dt} = 2 - 4t$$

$$v(3) = 2 - 4(3) = 2 - 12 = -10$$

$$P = (12)(10) = 120W$$

[8] A child of mass 40 kg slides down a rough slide as shown in Fig. 5. The coefficient of kinetic friction between the child and the slide is 0.2. If the child starts from rest at the top of the slide, at a height of 4m., then her speed when she reaches the bottom is

(a) 5.26 m/s (b) 8.94 m/s (c) 7.23 m/s (d) 10.37 m/s (e) other

Solution

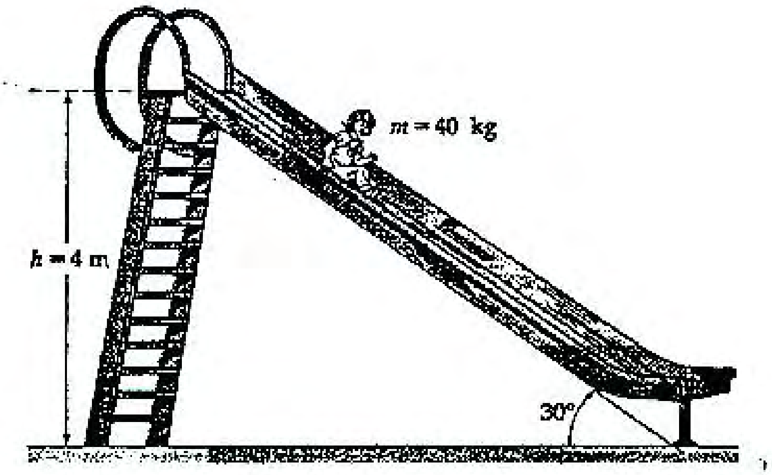

Fig. 5 Problem 8

$$\Delta E = E_f - E_i = W_{nc}$$

$$W_{nc} = -\mu_k mgd\cos 30 = -554.2$$

$$E_i = mgh = 1600J$$

$$v = \sqrt{\frac{2\times 1045.8}{40}} = 7.23m./s$$

[9] As shown in Fig 6, a 4-kg block slides along a track from point A toward point B at a higher level. The track is frictionless between points A and B. The rest of the track from point B to point C is rough with a coefficient of kinetic friction is 0.6. The block stops after compressing the spring for a distance d= 20 cm over the rough surface. If the initial speed of the block at point A is 8 m/s and the height difference h is 1.1 m, then the spring constant K is

(a) 3.96 kN/m (b) 7.92 kN/m (c) 8.360 kN/m (d) 8.840 kN/m (d) other

Solution

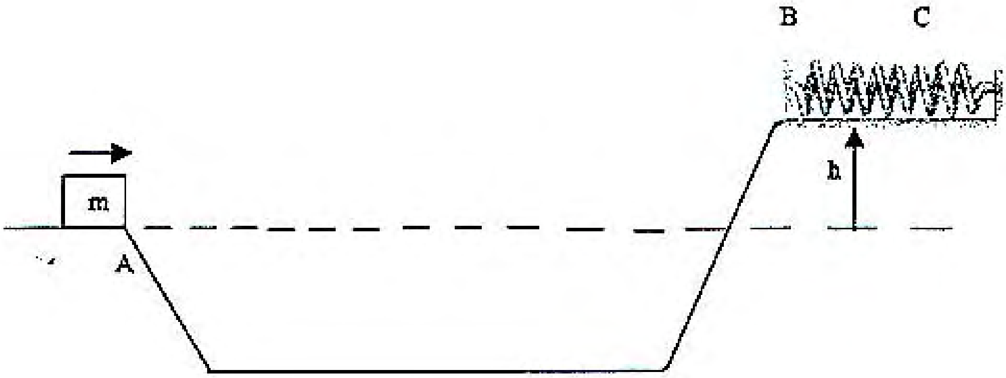

Fig. 6 Problem 9

$$\Delta E = W_{nc}$$

$$\Delta K + \Delta U_g + \Delta U_s = -\mu_k mgd$$

$$(0 - \frac{1}{2}mv_i^2) + mgh + (\frac{1}{2}Kd^2) = -\mu_k mgd$$

$$(0 - 0.5(4)(8)^2 + (4)(10)(1.1) + 0.5(K)(0.2)^2 = -0.6(4)(10)(0.2)$$

$$K = 3.96 \times 10^3 (N/m)$$